these rocks to the other similar materials in the Phlegræan region are next discussed, and the authors then pass to the structure of the island, which they show to consist of successive sheets or banks of ejected fragmentary volcanic material without any accompanying lavas, and disposed in the usual divergent arrangement, the portions on the outer surface of the cone dipping steeply outwards into the sea, while those on the inside are inclined towards the centre of the crater. Vivàra rises out of the Mediterranean as a truncated cone which attains a height of 109 metres and a diameter across its upper rim of about 900 metres. The eastern half of the cone has been broken down and the sea now fills the circular crater. The waves and rains have cut many sections of the rocks, and thus the structure of the old volcano has been admirably dissected. All students of vulcanology will welcome these memoirs and hope that they may be regarded as the precursors of a long series in which the volcanic history of Southern Italy will be thoroughly elucidated. ARCH. GEIKIE.

AGRICULTURE IN NEW SOUTH WALES.

THE *Agricultural Gazette* of New South Wales has ushered in the century, and, at the same time, marked the consummation of an Australian Commonwealth, by issuing a special federal edition. The history of the agricultural development of the Colony is dealt with in most interesting fashion by the chief inspector of agriculture, Mr. W. S. Campbell, who, in the hundred and thirteen pages that he appropriates, unfolds a fascinating tale of the early struggles and final success of this offspring of Great Britain, whose birth dates from the year 1788.

In the section devoted to chemistry in relation to agriculture a considerable feature is made of the value to the agriculturist of soil-analysis. Expert advice in the treatment of soils is said to be much sought after by the farmers of New South Wales, and a typical report on a poor soil is inserted with the view of showing the form that the information takes. The results of the physical and chemical tests are first tabulated, and from these the soil specialist formulates the following recommendations:—

"This is a very sour soil, low in plant-food, and only moderately supplied with humus. Its retentive power for water is low, consequently its power of resisting drought. It will not give the best results till sweetened and brought into good condition. The treatment recommended is, first, liming at the rate of about one ton per acre. This will sweeten the soil, and supply lime in which the soil is deficient. Then a quick-growing crop, such as vetches, lupins, cow-pea, &c., should be grown and ploughed under when just maturing. This will supply vegetable matter, improve the texture, and supply nitrogen, in all of which essentials the soil is weak. After this treatment the soil should be able, with proper manuring, to grow any of the ordinary fruits suitable to the district, such as are mentioned in your letter. Peaches and stone fruit should do very well, as well as any vegetables. With regard to the most suitable manuring, this should be on the lines recommended in the attached departmental pamphlet, 'Formulæ for Fertilisers,' which gives the manuring required for the different crops in average soil. In your case the quantities recommended may be somewhat increased. I would particularly impress upon you, (1) That this report is intended to be merely suggestive, and must be followed up by careful experiments on your own part; (2) . . . . (3) That you should impart to your neighbours any information you may gain from this report as freely as it is given to you; (4) That you should communicate regularly with the Department as to the results of your experiments, for we have special facilities for advising you as to the best manures for your special needs, and the cheapest form in which you can get the same."

This typical report is reprinted almost in full in order to show what the Department of Agriculture of New South Wales professes to be able to do in one section of the farmer's business, namely, the management of his soil. Experience in other countries has shown that advice given in the light of laboratory tests on soil is apt to be rather uncertain in its results, but in Australia science has, in this respect, it is said, been very useful to farmers. The practice of liming in that country seems to vary considerably from what holds in England. Where sourness in soil is the trouble an English farmer would consider a dressing of five tons of lime per acre none too much, but in New South Wales one ton is recommended as the maximum dose, to be repeated, if need be, a few years later.

Not the least interesting section of this federal number is that which treats of agricultural education. Technical instruction in agriculture appears to be eminently practical, and it is noted with satisfaction "that among the large number of young people so trained there are to be found so great a proportion who have achieved signal success upon farms and orchards of their own." The curriculum at the Hawkesbury College is almost rigorous in its thoroughness. The students who are on dairy duty turn out at 4.15 a.m., and are probably ready for their breakfast, which is served at seven. The sixty-five horses and mules that cultivate the College farm of 1100 acres demand the attention of another "gang" of students, whose day's work does not close till 8 p.m. Hard manual work does not appear to discourage the young farmer of New South Wales in his pursuit of knowledge, the present accommodation of the College being inadequate to meet the demands for admission. Some illustrations of the practical character of the education are culled from the interesting volume before us, which reflects a colonial vitality most gratifying to the mother-country.

CLIMATE AND TIME AND MARS.

THE astronomical theory of an Ice Age, of which the foundation is attributed to Adhémar, has been the subject of much discussion. Its laborious exposition by Dr. Croll has been justly considered a work of great merit, but it may be said to have proved more interesting as a speculation than convincing as an argument. The adequacy of the theory to explain all that is required of it is a highly controversial matter, and was debated with no little heat in the columns of this journal in 1895-6. Consequently it is desirable to state that this note is written from the point of view of qualified belief in the argument as expounded by Sir R. Ball.

The contribution of astronomy to the data of the problem can be very easily stated. Let us consider the northern hemisphere of a planet, the eccentricity of whose orbit, e, is sensible, but so small that only its first power need be taken into account. In the first place the ratio of the total solar radiation received in summer and winter is $1+a : 1-a$, where $a = 2 \sin \omega/\pi$, ω being the obliquity of the equator to the orbit. This is the law discovered by Wiener, and in the case of the earth $a = \cdot 25$. The ratio of the duration of summer and winter, *i.e.* of the periods between the equinoxes, is $1+b : 1-b$, where $b = 4e \sin \lambda/\pi$, λ being the true anomaly of the spring equinox. Hence the ratio of the mean heat received in a given time in summer and winter is $(1+a)/(1+b) : (1-a)/(1-b)$. In the southern hemisphere the corresponding ratio is $(1+a)/(1-b) : (1-a)/(1+b)$. At the present time $b = \cdot 02$, but in circumstances which would cause the earth's eccentricity to reach its maximum value (about $\cdot 0747$), $b = \cdot 09$ when $\lambda = 90°$. Under such conditions, then, the southern winter would un-

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doubtedly be more severe than at present, while the northern winter would be to some extent mitigated. Precession would have the effect of causing this state of things to alternate in the two hemispheres. The argument is perfectly simple and definite. and can only be questioned on the score of degree, not of fact. It thus passes from the domain of astronomy to that of meteorology. Here the ground is very debatable, and Mr. Culverwell's discussion of the solar radiation incident on individual zones of the earth may be regarded as a decided contribution to a study of this part of the question. But his researches do not seem to be necessarily so conclusive against the astronomical theory of an Ice Age as this author supposes. For the present purpose, however, enough has been said as to the application of the theory to our own planet.

The conditions which hold in the case of Mars resemble in a remarkable manner those which hold in the case of the earth, except in one particular. The eccentricity is ·0933, and hence $b = {\cdot}11$. The constant $a = {\cdot}27$. These values of a and b apparently afford an excellent example of the conditions required by the theory for a glacial epoch in the southern hemisphere of Mars. It would be illogical to compare the state of corresponding regions on the earth and on Mars, because the concomitant circumstances cannot be expected to be the same. But it is reasonable to suppose that in corresponding seasons the latter planet should show different phenomena in the two hemispheres. As an index of these variations we naturally look to the polar caps, the size of which is known to vary greatly with the seasons. The results to be expected are of this kind:

Hemisphere.	Season.	Duration.	Climate.	Size of Cap.
N	Summer	Long	Cool	Min.
N	Winter	Short	Mild	Lesser Max.
S	Summer	Short	Hot	Min.
S	Winter	Long	Cold	Greater Max.

The amount of heat during summer in either case being the same, there is room for question as to the relative size of the two minima. But it seems clear that the radiation incident on the southern hemisphere will be transformed into heat at a higher temperature than in the northern. According to the laws of thermodynamics it should, therefore, be more effective in the south. The total energy received is the same, but the available energy is greater. Or the matter may be considered differently. It is quite conceivable that during the long cool summer the temperature would not rise above the melting point of ice or whatever substance is in question, while it would be otherwise during the short hot summer. An approach to this condition would lead us to expect the more pronounced minimum in the southern hemisphere.

To compare the suggestions of theory with the facts of observation, we can turn to a recent paper on the subject by Mr. Lowell.[1] He concludes that the caps are composed of ice and not carbonic acid, on account of the difficulty of obtaining the latter substance in a liquid form, a state which he considers proved by observation to exist on Mars. He expresses a belief that the Martian sky is cloudless during the day and that the surface of the planet is protected by cloud at night. It must be confessed that the regularity of transition at sunrise and sunset from one condition to the other almost surpasses our belief and tends to discredit the deductions from the study of projections upon the terminator. Mr. Lowell then considers the evidence of the polar caps. The result is to confirm the expectations formed above, and the conclusion is perhaps the more convincing because the writer seems to find the phenomena surprising. And this point is rather important, for the evidence as to the maxima is not so complete as could be desired. It is to be hoped that Mr. Lowell's examination of this part of the question will lead to the acquisition of more complete and satisfactory evidence.

With regard to the minima, Mr. Lowell does not give the simple explanation suggested above, but attributes the phenomena observed to a deficiency of precipitation. In fact, he professes to prove that "as the precipitation increases a time must come when the southern minimum will actually exceed the northern one in size, *and do so more and more, indefinitely*." As no physical principle is invoked to account for this result, it would seem to be based on assumption. Examination shows that the assumptions tacitly involved are (1) that the maximum of each cap is increased in the *same* ratio, (2) that the amount melted at each cap remains exactly the same as before. It would then follow that in each hemisphere the rate of proportionate growth of the minimum would exceed that of the maximum. We now introduce the observed fact that the ratio of maximum to minimum is greater in the southern hemisphere. This, added to the foregoing, is necessary and sufficient to prove that the rate of proportionate growth of the minimum is greater in the southern than in the northern hemisphere. But the observed fact employed might equally well have been stated in this form: comparing the southern with the northern hemisphere, the ratio of the minima does not exceed the ratio of the maxima; and by assumption (1) the latter is constant. Hence, even on the assumptions the words italicised in the above quotation do not appear justified. The southern minimum may tend towards a relative increase, but there is a limit to the increase. The general idea is perhaps suggestive, but the second assumption involved must be considered highly improbable, and without it the whole theory fails.

At the end of the paper Mr. Lowell turns his attention to the eccentric position of the southern cap. He declines to believe that this well known peculiarity is due to local elevation, but, on the contrary, attributes it to a region of depression, where the cap has acquired an exceptional thickness. The phenomenon is a very curious one, but speculation as to its origin has probably not much value.

THE TELAUTOGRAPH.

IN an article on "Electric Signalling" which appeared recently in these columns (vol. lxiv, p. 6) we referred to the writing telegraph invented by Mr. Foster Ritchie. We have since had an opportunity of examining the instrument and seeing it at work, and are enabled to give a full description of it. The problem of devising an apparatus which should telegraphically transmit the actual handwriting or drawing of the person sending the message is one which has attracted a number of inventors. The difficulties to be overcome are, however, numerous, and in consequence up to the present no really satisfactory instrument has been invented. These difficulties seem to have been mastered in Mr. Ritchie's telautograph in a very ingenious manner, and the instrument is one which should prove thoroughly trustworthy and serviceable. Although it is not to be expected that the telautograph will replace ordinary telegraphic apparatus to any very marked extent, seeing that the speed of signalling is necessarily limited, yet there are numerous cases in which it should be of use. To give only one example, there are many persons possessing private telephone lines who would gladly supplement them with an instrument of this kind by which written instructions can be sent whether there is any one present to receive them or not. Other cases of like kind will doubtless occur to the reader.

One of the chief merits of the Ritchie telautograph lies in the fact that only two wires are needed to connect the

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[1] "Mars on Glacial Epochs," by Percival Lowell: *Proceedings* of the American Philosophical Society, Nov. 16, 1900.

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